REMARKS

Applicant respectfully requests reconsideration and allowance in view of the foregoing amendments and the following remarks. By this Amendment, claims 3 and 5 have been amended to correct minor typographical errors. Upon entry of the Amendment, claims 1-22 will be pending in the Application.

Rejections under 35 U.S.C. § 103

In the Office Action, claims 1, 4, 6, 11, 14 and 16 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over a paper titled "Physical Model-based non-rigid registration incorporating statistical shape information," by Wang et al. ("Wang") in view of U.S. Patent No. 6,067,373 to Ishida et al. ("Ishida"). Applicant respectfully traverses the rejections.

As noted in the Field of the Invention section of the present Application, the invention relates to a system and method providing fast, robust, *rigid* point matching of measured positions to template positions" (page 1, lines 9-12, emphasis added). The methods taught in the Wang reference are explicitly applicable to *non-rigid* registration (*see, e.g.*, Wang title and page 7, col.1, first paragraph). Therefore, it will be appreciated that present invention provides novel systems and methods that address deficiencies in the cited prior art (*see* Specification page 2, lines 9-12).

Claims 1 and 11 require acquiring measured data representing a set of measured point locations, comparing said set of measured point locations to template/reference data representing a set of template/expected point locations, defining force field vectors operative to perturb said measured point locations into alignment with said template/expected point locations. Claim 1 further requires matching measured point locations to template point locations, responsive to said defining. Claim 11 further requires selective repetition of steps including comparing said measured point locations perturbed by force field vectors and moment arms to said reference data, and redefining said force field vectors and said moment arms responsive to said comparing until predetermined convergence criteria have been satisfied. Wang does not teach or suggest these limitations.

Wang teaches a mathematical model for describing an observed deformation of a known object having a surface and certain topological properties. The model includes elastic, solid or viscous flow models (*see generally* pages 12-13). Wang derives a transformation that is used to

map deformations of observed objects consistent with the physical models (page 13, col. 1, line 20 – col. 2, line 9). Wang employs an algorithm based on linear elastic and viscous fluid models and gray level similarity and consistency measures to extract boundary information from an image. (Wang at page 9, col. 1, line 19 - col. 2 line 14). Wang teaches boundary control points with embedded shape information to enable correct mapping or registration (page 9, col. 1, lines 4-18). Wang also teaches the use of intensity information such that "the density of control points is not as important" (Wang at page 9, col. 1, line 28 - col. 2 line 2). Thus, the boundary control points in Wang are arbitrary and expendable and function solely to model a boundary during calculated deformation. Therefore, it is submitted that Wang cannot be said to teach the set of measured point locations recited in the claims.

Additionally, it will be appreciated that Wang is pixel-oriented and is not point-oriented. Wang teaches solutions based on the premise that "the deformed configuration of the atlas is always determined using only pixel to pixel intensity" (page 8, col. 2, lines 5). In Wang, shape information is embedded in boundary points to improve mapping and registration (Wang, page 9, col. 1, lines 4-18). Calculations taught in Wang confirm that Wang is directed to processing a grid of pixels rather than a set of measured points (*see* Wang, page 13, eqs. 10-12). Thus, Wang does not teach the acquisition of information related to a set of point locations but instead matches pixel intensities in an image to determine a best fit to a deformed model.

Nor does Wang teach force field vectors operative to perturb measured point locations into alignment with said template point locations. Wang teaches viscous fluid and linear elastic models for modeling the non-rigid deformation of an atlas (Wang, page 7, col. 1, line 10, col. 2, line 13). Even assuming, *arguendo*, that Wang's atlas is analogous to the presently claimed template point locations, Wang teaches the deforming of the atlas to fit a study image – a result opposite to the perturbing of measured point locations into alignment with template point locations. Applicant also observes that cited Figs. 2d, 2h, 3d and 3h are merely vector drawings representing displacement between atlas and sample images (*see* Figs. 2, 3 captions). These displacement vectors are insufficiently detailed to be representative of the complex viscous fluid and linear elastic forces used to model deformation in Wang (*see* Wang, section 3. Physical Models, page 12, col. 1 et seq.).

The Office Action acknowledges Wang's lack of force field vectors but suggests that Ishida cures the deficiency. Applicant disagrees and notes that Ishida is offered as teaching the altering of second images to match a first image. Ishida is directed to image processing systems that identify differences in successive radiographic images of a patient's chest (col. 1, lines 60-64). Specifically, Ishida teaches methods of subtracting prior images to reveal difference objects between the successive images and to compensate for differences in a subject's inclination and rotation (*see* col. 2, lines 18-24). In Ishida, regions of interest ("ROI") are identified in first and second successive images and shift values are calculated for pixels at the centers of respective ROIs in the images (col. 10, lines 56-64). Thus, Ishida merely teaches the shifting and transforming of coordinates in one image to obtain a best fit with another image (*see, e.g.*, Ishida Figs. 4b-4c). It is apparent that Ishida does not deal with discrete points and does not teach defining force field vectors to perturb measured points into alignment with template point locations. Therefore, the combination of Wang and Ishida does not render obvious defining force field vectors operative to perturb said measured point locations into alignment with said template point locations, and responsive to said defining, matching measured point locations to template point locations.

Claim 11 also requires selective repetition of certain steps until predetermined criteria have been satisfied. As cited, Wang does not teach such repetition until convergence. Wang teaches the uses of certain linear elastic, viscous fluid and statistical deformation modeling techniques (*see* pages 10-13). While mathematical calculations associated with these latter techniques may converge, the use of modeling techniques do not render obvious the selective repetition of comparing, to reference data, measured point locations perturbed by force field vectors and moment arms, and redefining said force field vectors and said moment arms responsive to said comparing until predetermined convergence criteria have been satisfied.

Therefore, for at least these reasons, the rejections of claims 1 and 11 should be withdrawn.

Claims 4 and 14 require utilizing a one-to-one point matching algorithm to match measured point locations to template point locations. Wang is directed to pixel intensity matching and teaches the use of viscous fluid and linear elastic modeling techniques to obtain surface deformation models. It cannot be said that Wang teaches or suggests the required on-to-one point matching.

Regarding claims 6 and 16, Ishida does not teach or suggest force field vectors (see above). Nor does Ishida teach a prescribed range over which force field vectors act. Ishida refers only to "regions of interest" that indicate an area of graphics containing, for example, a lung or section of lung and are unrelated to force field vectors. Thus, Wang and Ishida cannot be said to render obvious creating force field vectors to act over a prescribed range.

For at least these reasons, claims 1, 4, 6, 11, 14 and 16 patentably define over Wang and Ishida and the rejections should be withdrawn.

In the Office Action, claims 2 and 12 stand rejected as being unpatentable over Wang in view of Ishida and further in view of U.S. Patent No. 5,946,425 to Bove Jr. et al. ("Bove"). Applicants respectfully submit that claims 2 and 12 are allowable for at least the reason that claims 1 and 11, upon which they respectively depend, are allowable. In addition, Bove does not teach or suggest a many-on-many point matching algorithm as required by the claims. Bove teaches a method dealing with subregions that are vector mapped between sets of scan slices (Bove at col. 2, lines 30-41). Thus, Bove is not directed to point matching, but instead is directed to subregion mapping. Bove explicitly "dispenses entirely with the need to identify corresponding anatomical landmarks" and it is submitted that Bove therefore cannot be said to teach point matching, since points would be considered anatomical landmarks (*see* Bove at col. 2, lines 20-22). For at least these reasons, the rejections of claims 2 and 12 should be withdrawn.

In the Office Action, claims 3 and 13 stand rejected as being unpatentable over Wang in view of Ishida and Bove and further in view of U.S. Patent No. 6,414,477 to Strom ("Strom"); claims 5, 15, 18-21 stand rejected as being unpatentable over Wang in view of Ishida and further in view of Strom. Strom does not cure the deficiencies of Wang-Ishida or Wang-Ishida-Bove. As shown above, combinations of Wang, Ishida and Bove do not teach force field vectors. As acknowledged in the Office Action, Strom is cited to teach offset values that are distance and angular values. Therefore, the combination of Wang, Ishida, Bove and Strom cannot be said to render obvious claims 3, 5, 13, 15, 18-21 and the rejections should be withdrawn.

Further, regarding claims 18-21, Wang, Ishida and Strom are further distinguishable from the presently claimed invention because the references fail to teach the required set of probe point locations. Specifically, Wang is directed to a grid of pixels and arbitrarily assigns control points to

model a boundary within an image (see above). Neither Wang nor Ishida teaches a probe point or any physical entity located at a specific point in space that may be perturbed by force field vectors and moment arms. Strom does not cure the deficiencies of Wang-Ishida. Strom is directed to the measurement of scrub marks on a semiconductor test wafer (Strom col. 3, lines 56-65) and does not teach the acquiring measured data representing a set of probe point locations. Absent such teaching, Applicant respectfully submits that the resulting combination Strom with Wang-Ishida does not teach every element of the claims. Therefore, for at least these reasons, the rejections should be withdrawn.

Allowable Subject Matter

Applicant thanks the Examiner for acknowledging the Allowable subject matter in claims 7-10, 17 and 22. However, Applicant believes that the independent claims and other dependent claims are also allowable over the art of record and defers amending claims 7-10, 17 and 22 until prosecution of the remaining rejections has been concluded.

CONCLUSION

Based at least upon the foregoing Remarks, Applicants respectfully submit that all the pending claims are allowable, and that the present application is currently in condition for allowance. The Examiner is encouraged to contact the undersigned at 858-509-4007 if it is believed that a discussion may advance the prosecution of this case.

The Commissioner for Patents is authorized to charge any required fee to Pillsbury Winthrop Shaw Pittman LLP's deposit account No. 033975 (order no. 044182-0308725). The Commissioner is also authorized to credit any over payments to the above-referenced Deposit Account.

Respectfully submitted,
PILLSBURY WINTHROP SHAW PITTMAN LLP

Dated: November 16, 2005

By:

Anthony G. Smyth
Registration No. 55,636
PILLSBURY WINTHROP SHAW PITTMAN LLP
11682 El Camino Real, Suite 200
San Diego, California 92130-2092
(858) 509-4007

CERTIFICATION UNDER 37 C.F.R. §§ 1.8 and/or 1.10*

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I hereby certify that, on the date shown below, this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Signature

Date: November 16, 2005

Sachiko Y Snedden
(type or print name of person certifying)

** Only the date of filing (§ 1.6) will be the date used in a patent term adjustment calculation, although the date on any certificate of mailing or transmission under § 1.8 continues to be taken into account in determining timeliness. See § 1.703(f). Consider "Express Mail Post Office to Addressee" (§ 1.10) or facsimile transmission (§ 1.6(d)) for the reply to be accorded the earliest possible filing date for patent term adjustment calculations.*